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Final Report: - N00014-91-J1016 (POR3929- Fund 23093A).
Project Period: 1 Oct. 1990 - 30 Sept. 1997
Title: "Upper Ocean Circulation"
Principal Investigator: Peter Niiler

Abstract: The "Upper Ocean Circulation" project was based on observations of circulation with drifters, bottom pressure gauges and current meters and the interpretation of these data on basis of conceptual and hydrodynamic models of the mixed layers, mesoscale and their interactions. The focus was in the north-eastern Pacific phenomena. The principal findings were: i) models demonstrate that mesoscale eddy circulation is significantly changed by the nonlinear interaction of the wind and eddy vorticity.; ii) the eastern Pacific mesoscale is observed to be more important to the dynamics of the propagation of near inertial motions than is the beta effect ; iii) a new data set of upper ocean circulation in the California Current was acquired with drifters and moorings. Wind driven motions, both barotropic and Ekman, account for significant part of the variance of circulation and sea level variability; iv) zonal shear on the scale of 1500km and amplitude of 12-15 cm/sec with respect to 1500m was measured in the subtropical Pacific. This phenomenon has yet no theoretical explanation; v) an eddy resolving, biologically active general circulation model has been configured for the California Current system.

Accomplishments: The California Current system and the eastern North Pacific was the laboratory in which the "Upper Ocean Circulation" project was conducted. The early focus was on the observations of the statistical nature of the California mesoscale and its interaction with the coastal zone (# 3,4,5,6,18,). This was followed with the description of the large scale fields, in which the eddies continue to play an important role (#2, 8, 11, 12, 13, 15, 17, 20, 22). Observations of the fate of near-inertial motions in the upper ocean again demonstrated the important effect of the ocean mesoscale (#14, 24). Modeling of the upper ocean wind-driven circulation with the mesoscale was the next topic (#10, 23). The continuous thread through all these investigations were the discoveries that the ubiquitous mesoscale, while in the eastern Pacific having energy several orders of magnitude smaller than in the western Pacific, played a crucial role in how the observations were interpreted and how the circulation evolved in the models. The details of the eddy interactions with the general circulation as well as the ocean adjustments to new forcing conditions formed the basis of the published research findings. Not yet published, are the results of integrations of California Current eddy resolving models.

The second important accomplishment was in the area of developing a calibrated upper ocean drifter (#16). For over a hundred years oceanographers have used drifting objects to infer ocean circulation, but before this project, no one had calibrated or understood quantitatively how well a particular object followed the water. The principal finding was that the drogue has to be five times larger than ocean engineers had speculated should be sufficient for accurate water following capability. This accomplishment was instrumental in the development of a global ocean circulation observing system, based on modern, low cost drifters. Secondly, a calibration of the TOPEX capability for measuring the geostrophic surface current was assessed by comparison with current meter data (#21). A 50-70 km average slope of sea level must be used to effect accurate calculations in the California Current system.

Dr. Pim- Van-Meurs obtained a Ph.D. under the sponsorship of this project. Dr. Jeff Paduan, Dr. John Lee, Dr. Mark Swenson and Dr. John Moisan were post-doctoral fellows.

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